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Edward Lewis Brady, who recently retired from his position as associate director for international affairs at the National Bureau of Standards, died on September 20, 1987. This issue of the *Journal* is dedicated to his memory.

Born in Charleston, South Carolina, in 1919, his undergraduate education took place at the University of California at Los Angeles, where he received a BA and MA in chemistry. From 1942, when he joined one of the major laboratories of

the atomic bomb project at the University of Chicago, until he came to NBS in 1963, Brady was involved with nuclear energy research and development. His war-time service included work at Clinton Laboratories in Oak Ridge, Tennessee, the forerunner of the present Oak Ridge National Laboratory, where he was a member of the group that designed and operated the first large-scale hot laboratory facilities.

During his graduate studies and re-

search at the Massachusetts Institute of Technology, he published with Martin Deutsch, in 1947, the first measurements of the angular correlations of successive nuclear gamma radiations. This and a series of subsequent publications established an important technique that is widely used in nuclear and elementary particle physics.

After receiving his PhD in 1948, he spent 10 years in various capacities with the General Electric Company. While at GE's Knolls Atomic Power Laboratory, he led a research group working on coolant chemistry and a group developing equipment for in-pile tests of reactor materials.

From 1956 to 1958 he served as U.S. Atomic Energy Commission Representative to the United Kingdom and later was the senior scientific advisor of the U.S. Mission to the International Atomic Energy Agency in Vienna. He left Vienna in 1961 to go to General Dynamics Corporation in San Diego where he was responsible for various projects connected with chemical and materials problems of nuclear power plants.

In 1963 the National Bureau of Standards, acting on a recommendation of the Federal Council for Science and Technology, established the National Standard Reference Data System (NSRDS). The system was set up to coordinate the data compilation efforts of government and private-sector groups and to provide critically evaluated data on the physical and chemical properties of substances required by U.S. science and industry. Ed Brady was recruited by NBS to head this program. He set up the Office of Standard Reference Data, organized support for data centers at NBS, universities, and National Laboratories, and started a publication program for reference data. His interest in this program continued for the rest of his career; at the time of his death he was U.S. Delegate to CODATA, the Committee on Data for Science and Tech-

nology of the International Council of Scientific Unions.

In 1968 his responsibilities at NBS were broadened to include all of the Bureau's programs which gather, analyze, publish, and distribute scientific and technical information. Throughout his career at NBS, he felt it was vital to get the technical information of the Bureau to those who needed it. In a statement before Congress in 1971, he said, "Information is the key to wise management of our future. Perhaps the most important event of the next decade will be the recognition of the true value of information—the right information, reliable, and relevant to our needs, available in a useful form to all those who need it."

Ed Brady carried this philosophy with him to his next position at NBS, when he was named Associate Director for International Affairs in 1978. With his breadth of scientific knowledge, graciousness, and congenial manner, he established official links and made many friends in government research centers around the world. He was instrumental in drafting agreements to guide the United States' exchange of scientific and technical personnel with the Union of Soviet Socialist Republics and the Peoples Republic of China. He negotiated agreements for technology cooperation with numerous countries, developed policy for implementing U.S. treaties in many areas of science and technology, and established mechanisms for exchanging technical information among countries. For his achievements, he was honored in 1980 with the Department of Commerce Silver Medal Award for meritorious service.

In addition to being a respected scientist, Edward Brady was a born diplomat able to bring order out of chaotic situations with quiet logic and unbounded optimism. His friends in both the science and diplomatic communities were legion and his enemies nonexistent.

Commentary

International Cooperation in Science and Technology: U.S. Government Activities

Edward L. Brady

Associate Director for International Affairs
National Bureau of Standards

I. Purpose of this series of articles

In all human intellectual activities, additions to knowledge may originate in any part of the world, in science and technology as well as in philosophy and art. Thus, anyone who wishes to keep up with the latest developments in his own field must be aware of progress in other countries. Also, those who wish to reduce their own work-loads and speed progress by sharing must consider how they can best benefit through cooperation with colleagues in other countries. This is true for the governmental scientific enterprise as well as for the private sector. A full discussion of the role of the U.S. Government in international scientific and technological cooperation would have to be as broad as the whole range of Government activities, a task obviously too large for an issue of this publication. The editor, Prof. Irving Gray, decided that his

readers might be interested in a brief overview and sampling to illustrate some of the ways that U.S. Government agencies help to promote Government objectives through international cooperation.

This series of articles is the result of his request to the author of this paper to organize a set of papers for this purpose. The reader should not expect a comprehensive review of the range of Government agency programs, but should expect to see short expositions on a few selected topics. The authors are senior scientists who have devoted substantial fractions of their professional careers to responsible positions in international affairs. Through their descriptions of the activities in which they are experts, we hope to give an impression of the scope, the importance, and the mechanisms of U.S. Government participation in international science and technology.

II. Technical scope of international cooperation

With the possible exception of some areas of military science and technology, international cooperation—and competition—is pervasive throughout most Government agencies. This is true for all those concerned with the physical sciences, biological sciences, geosciences, and their technological incarnations, at least to the point at which commercial sensitivities become apparent. Sometimes, of course, the commercial significance is not apparent until after information of commercial importance has been transferred; this can lead to problems in international commercial competition. Even in pure science, competition for intellectual priority can be very keen.

The authorities in every country that aspires to have an industrial economy have settled on a common set of research priorities; they include advanced materials, especially ceramics; biotechnology; manufacturing engineering; semiconductor technology; optical communications; computer science and technology; and perhaps a few others. In these areas the boundary between basic science and commercial significance becomes rather indistinct. In the United States, the decision on where cooperation ends and commercial competition begins has generally been left to the judgment of local management.

Many proposals have been made for cooperation in these priority fields—some bilateral, some multilateral, and some private sector. Indeed, international cooperation is characterized by a diversity of partners, organizational arrangements, funding arrangements, and motivations. One purpose of this series of articles is to illustrate this diversity.

III. Private sector vs public sector

Our intent at present is to focus on public sector activities only—that is, activities of U.S. Government agencies, with spe-

cial emphasis on activities of the National Bureau of Standards, since most of the authors have been associated with NBS for many years. This is not intended to imply that private sector activities are of lesser importance; indeed, the opposite is undoubtedly true. For basic science, cooperation through universities and international nongovernmental organizations is undoubtedly the most extensive and most effective channel. For industrial technology, cooperation through licensing agreements, joint ventures, and establishment of subsidiaries is the normal mechanism.

In some important areas of technology in which Government laboratories have major responsibilities, such as space, nuclear power, weather and climate, marine sciences, and metrology, Government agencies have lead roles. In many areas of basic and applied sciences and technology, both the private sector and government are major figures. So keep in mind that since U.S. Governmental activities are emphasized in these reports, the great bulk of international cooperative programs probably is not addressed.

IV. Objectives of the United States Government

Let us now examine the reasons why the U.S. Government engages in international cooperative activities in science and technology. That is, what foreign policy goals are served by such activities and what do the technical agencies involved receive for their efforts? The Government and agency objectives are briefly described below.

1. To share the work and the cost. This objective is most conspicuous for "Big Science" projects: the Superconducting Supercollider, space stations, mapping the human genome, and the like. But it is also important for sharing the workload of making small incremental contributions to large bodies of knowledge.

2. To obtain information on transnational phenomena. Such phenomena include weather, air pollution (for example, acid rain, a sensitive subject at the moment), marine sciences, diseases of humans and animals, and geological structures.
3. To obtain access to products or observations not available in the United States. Examples include access to animal and vegetable gene banks, local minerals, and geological structures, and the opportunity for anthropological studies of local populations.
4. To ensure current awareness of worldwide technical developments. New science and new ideas can appear anywhere in the world. Constant diligence is needed to ensure awareness of something important, and cooperative activities involving person-to-person communication are the most effective means of exchanging information.
5. To promote U.S. technical positions and practices. The promotion of U.S. positions and practices is especially important in international measurement and standards bodies to ensure compatibility. This minimizes obstacles to trade and reduces disputes over quantities and performances of products.
6. To promote achievement of domestic technical objectives. Accomplishment of technical objectives can be aided greatly by seeking research capabilities found in other countries and agreeing with them upon an equitable distribution of research tasks. Long term linkages between institutions can especially facilitate progress.
7. To promote foreign policy objectives. For many years, cooperative arrangements in science and technology have been used as a policy tool to initiate or to warm up relations with another country, or even sometimes to keep open a doorway through which human contact can be maintained. In other circumstances, S and T cooperation can promote trade with a newly industrializing nation, or can serve U.S. aims of

aiding the economic and social development of a low income country.

V. Mechanisms for cooperation

With the wide diversity of subjects and objectives, it is not surprising to find a wide diversity of organizational structures employed for these international activities. U.S. Governmental agencies participate in bilateral, multilateral, nongovernmental, and intergovernmental arrangements. A few examples will illustrate this diversity.

The United States has signed bilateral umbrella agreements with more than 20 other countries: for example, Korea, China, Yugoslavia, Italy, Finland. Under these umbrellas, various agencies have signed separate agreements with counterpart agencies in the other country. A typical example is the Protocol for Cooperation between the Department of Commerce and the State Bureau of Metrology of the People's Republic of China, which is one of twenty-seven similar protocols. Another example is the U.S.-Yugoslavia joint research program under which several U.S. agencies cooperate with counterpart organizations with funding jointly provided by the two governments.

Another common mechanism is participation in programs of an international intergovernmental agency, such as the International Atomic Energy Agency, the UN Environmental Program, the World Health Organization, the International Organization for Legal Metrology, and the Treaty of the Meter. In these latter two organizations, the National Bureau of Standards represents the technical interests of the United States; these organizations will be described in more detail in a later article in this series.

A third common organizational arrangement is the nongovernmental international organization, in which the technical community of the nation is represented by private sector organizations. Examples are the numerous In-

ternational Scientific Unions, in most of which the United States is represented by a "National Committee" under the auspices of the National Academy of Sciences. Other examples are the International Organization for Standardization and the International Electrotechnical Commission, the two principal organizations that develop international standards, in which the interests of the United States are coordinated by the American National Standards Institute.

VI. Summary

The purpose of the foregoing brief outline was to introduce the breadth and complexity of the many types of international cooperative activities in which Government scientists and institutions participate. In the rest of this series of articles special aspects of these programs

will be discussed and some illustrative activities described in more detail. The next article deals with the very extensive bilateral program carried out with Japan, written by a man who served for five years as the American Science Counselor in the embassy in Tokyo. The third article will illustrate U.S. participation in intergovernmental organizations by describing our involvement in the Treaty of the Meter and in the International Organization of Legal Metrology, co-authored by me and David E. Edgerly, who has managed U.S. participation in OIML affairs for the past eight years. The fourth article deals with technical assistance to developing countries, written by a man who has specialized in helping developing countries improve their technological infrastructures for nearly twenty years. Finally, the role of the American science attache program will be discussed by a man who served as the American Science Counselor in Mexico City, Bonn, and Paris.

Bilateral Cooperative Programs: A Case Study—The United States and Japan*

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Introduction

One could deduce from reading the newspapers these days that Japanese competence in high technology either has just emerged or has just been discovered. In truth, relatively large numbers of American scientists and engineers have watched the growth of Japanese scientific and technical skills for the past 40 years and have cooperated and even participated in one part of Japan's R&D effort over this period: government-sponsored programs for the public benefit. To these Americans, Japan's technical accomplishments in the industrial and commercial field come as no surprise. However, they have been ineffective in communicating their observations and findings to others not involved. Stated another way, there had been little interest in the U.S. in

learning about the nature of or the process for conducting R&D in Japan until Japan's economic prowess had grown to the point of being what is now called a threat. The reasons for this lack of interest are well known to the U.S. technical community and will not be repeated here. Although it is very late, the surge of activity presently devoted to the study of Japanese research accomplishments and the methods and facilities employed is a healthy sign. In this sense, it is still worthwhile to examine Japan's governmental R&D program as seen through the eyes of Americans who have been privy to it through the U.S.-Japan bilateral political relationship.

The History of Bilateral Cooperation

The end of World War II in the Pacific also marked the beginning of a remarkable era of technical cooperation between the U.S. and Japan. Prior to the War there had been countless exchanges of technical information through commercial ventures

*An earlier but more detailed report on this subject may be found in *Scientific and Technological Cooperation Among Industrialized Countries: The Role of the United States*, Mitchell B. Wallerstein, Ed. Washington, D.C.: National Academy Press, 1984, pp. 84-110.

and through the contacts made by individual scientists of both countries, but there was little or no government participation or involvement. Of course, all of these relationships were broken during the War and then had to be slowly regained during the postwar reconstruction period. At that point, however, a new force emerged as a consequence of the generally benign attitude taken by the U.S. toward vanquished Japan, in that the American occupying authorities actively encouraged official scientific and technical interactions almost immediately.

Studies of Medical Effects of Radiation and Other Beginnings

On October 12, 1945, a military commission was created by President Truman's executive order to enable American and Japanese medical scientists to work together to evaluate the devastating biological effects of the atomic bombings of Hiroshima and Nagasaki. Their cooperation was exemplary, and a year later a permanent civilian body, the Atomic Bomb Casualty Commission (ABCC), was established. It functioned in Japan until 1974, when it was replaced by a binational organization, the Radiation Effects Research Foundation (RERF). This succession, while not free of political problems, has performed outstanding research on the biological effects of ionizing radiation in an emotionally charged environment, largely because the scientists involved were free of rancor and recognized that the importance of their work transcended the strains left by the war.

From this beginning, many other positive events transpired. A scientist from MIT, Dr. Harry Kelly, was appointed to be the technical advisor to General MacArthur's staff; he proved to be only partially successful in stopping the dismantling of small cyclotrons found in Japan after the war, but he endeared himself to the Japanese for his efforts in reestablishing academic and other forms of technical relationships. He was to be

the first of a succession of scientists and engineers who have served the U.S. Government as counselors or attachés in Tokyo.

During the occupation the U.S. acted quickly to help in restoring the Japanese economic, political, and educational infrastructure. For example, the Corps of Engineers and private organizations in the U.S. enabled Japan's railroad system to be rebuilt in a remarkably short time—an accomplishment that was still remembered by the Japanese decades later. Similar foundations were laid in helping the Japanese convert their pre-war imperial universities to a network of democratically organized national universities and in setting up a modern public health system. However, these activities took place largely before a democratic government replaced the American occupying forces.

Nuclear Energy

By 1958, Japan was well along the road to economic recovery and trying to take its place among the advanced nations of the West. In that year, the U.S. entered into a formal bilateral agreement with Japan covering cooperation in the peaceful uses of nuclear energy—the first such agreement with an individual country under the Eisenhower Atoms for Peace program. While safeguards against proliferation of nuclear weapons may have been uppermost in the minds of the Washington authorities who executed the agreement, the agreement enabled Japan to begin what is now one of the world's largest and most effective nuclear power programs through the acquisition of American technology, materials, equipment, and know-how. The U.S. reaped large financial benefits as a result, not only through commercial sales but also through Japanese participation in U.S. nuclear R&D programs still in effect. It is not widely known that the Japanese Government has invested upwards of \$150 million in these programs, making it the largest foreign contributor by far. Of course, the argu-

ment can be made that Japan has been able to avoid making even larger expenditures internally by doing so, but it can also be said that a number of U.S. nuclear R&D projects would have been cancelled if it had not been for the Japanese involvement. Also, at least in this field, the Japanese have not yet attempted to enter foreign markets on a large scale with the skills that they have developed. Some other countries have not been so reticent. Lastly, it must be recognized that the bilateral nuclear program has survived a number of attempts by the U.S. to impose its non-proliferation policies on Japan that would have severely constrained the latter's attempts to reach equality in technology with the U.S. and other advanced nations.

Basic Sciences

Another far-reaching bilateral agreement recently celebrated its 25th anniversary. It is concerned with cooperation in the basic sciences and is administered by the National Science Foundation for the U.S. side and for Japan by the Ministry of Education's Japan Society for the Promotion of Science. Through it, thousands of academic scientists from the two countries have participated in cooperative research, joint seminars, and large-scale conferences covering almost every field of scientific endeavor. Japan is not known for its scientific accomplishments, no doubt in part due to difficulties in communication with the rest of the world. Through the bilateral science agreement, Americans have been exposed to ongoing Japanese scientific efforts in ways that cannot be matched by reading the literature. The consequences have been most favorable, according to the participants, and NSF states that its agreement with Japan is among its most important international agreements. The intensity of effort is such as to require maintaining an NSF office in Tokyo—the only one NSF has abroad serving a single country.

Natural Resources Development

In 1964, another bilateral agreement was signed that was intended to provide a vehicle for cooperation in applied research as a counterpart to cooperation in the basic sciences. It has the cumbersome name of "United States-Japan Conference on the Development and Utilization of Natural Resources" but is better known by the abbreviation "UJNR." It is almost unknown to the public and even to most scientists and engineers, since it is administered and implemented almost entirely by government personnel. The fields covered can be categorized roughly as falling within the scope of marine engineering, agricultural sciences, and disaster prevention. Notwithstanding the fact that the U.S. budgets no funds specifically for the purposes of the UJNR agreement, it also has been highly successful. NOAA is responsible for the marine activities and the Department of Agriculture for the remaining subjects, but several other Federal technical agencies participate as well. Seventeen panels meet annually or biennially to exchange information and to make site visits. Since Japan is among the most advanced nations in the fields covered, the U.S. has learned much from the involved Japanese agencies. In a number of cases, research facilities in Japan are unique and have no analogues here.

Medical Sciences

In addition to the work carried out by RERF and some biological work under the cooperative sciences agreement, a number of agreements are in effect covering a broad range of medical research. The earliest of these was initiated in 1965 and was originally devoted to joint study of diseases and medical problems endemic to Southeast Asia, such as cholera, leprosy, tuberculosis, viral diseases, and parasitic diseases. In later years, after most of these diseases had yielded to treatment, collaboration between the American and Japanese doctors shifted to

studies of advanced medical disciplines associated more generally with infectious diseases. In 1974, a separate agreement was signed to cover cancer research specifically. Both agreements are characterized by extraordinarily close interactions, notwithstanding the fact that the U.S. spends orders of magnitude more on biomedical research than does Japan. One factor leading to this intensity of cooperation is that most Japanese research physicians have been educated abroad (particularly in the U.S.) and they speak fluent English. Other smaller and less intensive agreements are devoted to vision research, shellfish sanitation, and regulation of food products, pharmaceuticals, biologicals, and medical devices. The National Institutes of Health (primarily the National Institute of Allergy and Infectious Diseases and the National Cancer Institute) and the Food and Drug Administration are responsible for maintaining the U.S. role in this aspect of the relationship.

Environmental Protection

Strong environmental movements emerged at about the same time in the U.S. and Japan. If anything, Japan's environmental problems were worse than those of the U.S.—aggravated by inattention during the period when Japanese industry was rushing to make itself productive. By 1975 the two countries were the most advanced among the large nations in technology for controlling pollution and in instituting protective measures. In that year a bilateral agreement was signed to enable exchanges of technical and regulatory information to occur. Fourteen specific areas of cooperation were identified and teams of specialists were soon traveling in both directions across the Pacific under the coordination of the U.S. Environmental Protection Agency and the Japanese Environment Agency. Although the two national programs were much different in size, the Japanese were able to offer certain technologies that were not available in the

U.S., particularly in sewage treatment, solid waste management, and stationary source pollution control. A very productive relationship was established and remained in effect until 1981, when changes in U.S. policy and political problems within EPA caused a reduction in interest in bilateral environmental affairs. Although the agreement remains in effect, there no longer appears to be the vitality and enthusiasm that was observed earlier.

Applications of Outer Space

Japan was late, compared to the rest of the advanced world, in exploring the practical use of outer space. It has no large-scale missile program to provide booster rockets, telemetry, launch sites, and other necessary facilities and components needed for a space program, and it has therefore employed its now well-known practice of introducing foreign technology to short-cut the development process. The first satellites placed in orbit by Japan were for research purposes only and were developed under a small program conducted under the sponsorship of the Ministry of Education by the University of Tokyo. In the late 1960s, a public corporation more or less analagous in its functions to NASA was created that was called the National Space Development Agency (NASDA). Funded by the Science and Technology Agency, NASDA hired large Japanese industrial companies to perform development work, and these companies in turn entered into contracts with American aerospace companies to purchase hardware and technology. These transfers were authorized by a succession of diplomatic notes exchanged between the two Governments beginning in 1969. The U.S. placed severe restrictions on Japan as to how it might use the acquired technology; on the other hand, Japan is the only country that has received such technology from the U.S. and it has been able to establish a capability in space at a much lower cost than would have been necessitated by purely indigenous development.

The Japanese space program is small

by U.S. standards but it has been highly successful. Launch vehicles based on the U.S. Thor Delta design (1969 vintage) have never experienced a failure, although some of the applications satellites failed to achieve geostationary orbit or ceased to operate after doing so. In 1981 Japan began to drift away from using American assistance under governmental authorization when the U.S. declined to provide more advanced launch vehicle technology such as inertial guidance systems and cryogenic propulsion. Today the Japanese program has successfully deployed a larger booster using cryogenics and has developed its own inertial guidance hardware. However, close interactions with the U.S. continue to exist in other ways. Japan is developing a large payload for the Space Shuttle that will test materials processing in space and will for the first time be operated by Japanese payload specialists. Japanese participation in the proposed Space Station is actively being solicited by NASA, with the Japanese financial contribution expected to be in excess of one billion dollars.

In the private sector, at least two U.S.-Japan joint ventures have been formed to develop and launch large communications satellites. They represent a retreat by Japan from its original intention of pursuing this development alone.

Energy Research and Development

By the late 1970s, Japan's prowess in developing industrial technology had become increasingly apparent, and for the first time Japan took the initiative in proposing a large-scale cooperative agreement with the U.S., devoted to R&D on alternative energy sources other than nuclear fission. This agreement was to replace a similar one signed in 1974 that had been relatively ineffective, and it was to be jointly funded. Japanese interests lay in plasma fusion and photosynthesis. The U.S. offered cooperation in developing synthetic fuels from coal, high energy physics, and other energy-related topics. After lengthy and sometimes contentious

negotiations, a high-level agreement was signed in 1979. The net effect of the concord was that Japan markedly increased its investment in U.S. energy R&D projects, while obtaining no return investment. Furthermore, the U.S. refused to cooperate in first-line fusion projects, believing that it was ahead of Japan and not wishing to potentially relinquish that lead. The agreement was severely marred in 1981 when the tripartite (U.S.-Japan-Germany) SRC II coal conversion project was cancelled by the U.S. Except for coal technology, cooperation under the agreement has improved somewhat since 1981, in recognition of the fact that Japan, mostly by itself, has reached the world class in fusion, high energy physics, solar and geothermal energy, and energy conservation technology. For example, Japan is expected to be a major financial and technical partner in the Superconducting Supercollider particle accelerator.

An "Umbrella" Science and Technology Agreement

On the heels of concluding the energy R&D agreement, President Carter proposed to the late Prime Minister Ohira that their two nations enter into a more comprehensive scientific relationship that would act as an "umbrella" for the many other agreements already in effect. Once again it was designed by the U.S. to extract more funding from Japan for U.S. R&D projects. The Japanese reluctantly acceded to the pressure and a new agreement was signed by the heads of state in May 1980—the only one to be given such high-level attention. However, it has not been a successful arrangement in terms of the original U.S. objective, and it is burdened by a cumbersome management structure that has inhibited more altruistic intentions. Upon conclusion of the initial five-year term in 1985, the agreement was renewed for two years and is now once again receiving attention at high levels in Washington and Tokyo as its termination approaches. In light of the tensions due to trade friction that now exist between

the two countries, the future of the Science and Technology Agreement is in doubt.

Another Recent and Novel Cooperative Arrangement

Space does not permit describing the very large number of smaller-scale agreements that have been executed by individual agencies of the two Governments. In fact, a catalog of them probably does not exist. However, to demonstrate the breadth of such undertakings, one that is quite unusual is described here.

In 1983 the National Bureau of Standards entered into an agreement for exchanging technical information in the field of telecommunications with the Nippon Telegraph and Telephone Public Corporation (NTT). NTT at the time was not a Japanese Government agency in the formal definition, since it operated out of revenues obtained from its services and was not staffed by civil servants. Its laboratories are among the largest in the world and are devoted exclusively to telecommunications and allied technology. NBS, on the other hand, is a Government agency as an arm of the Department of Commerce, and its research in the field of telecommunications is a small part of its total effort. It must be borne in mind also that this field is the subject of considerable trade friction between the two countries. Nevertheless, the exchange of information between two organizations that do not appear to fit well together has been excellent and is moving in the direction of exchanges of personnel. The mismatch in structure has been increased by the recent privatization of NTT. Now NBS has an agreement with a private corporation in Japan that is a world leader!

A Concluding Analysis

Forty years of intensive and extensive technical cooperation, largely unsung and

therefore unknown to the American public, have taken place between the U.S. and Japanese Governments. Although at first these programs were politically motivated and designed to help Japan to recover from the devastation of war, they emerged later as a means for exchanges of advanced technical information approaching equilibrium in two-way flow. Japan has recognized the intellectual debt it owed to the U.S. for the assistance received by giving the U.S. a special place in its international technical relations and by investing heavily in U.S. Government R&D programs. Another indirect benefit of the cooperation has been the acculturation process that has taken place: many American scientists and engineers have become familiar with Japan and the Japanese people as a consequence and generally have liked what they have seen and heard. However, this has been insufficient to markedly influence or overcome the clouds of suspicion in the U.S. about Japanese motives in acquiring technology and becoming what some believe is now the leading economic power of the world.

The relationship with Japan has been unique. Taking all factors into account such as population size, degree of education, political acceptability and stability, and quality of the technical establishment, it is doubtful that any other country will be treated similarly by the U.S. It also appears to be true that the U.S. is more comfortable with a relationship in which the U.S. dominates the scene and offers largesse freely and in great amounts. When another country approaches the competence of the U.S., fears of competition may arise to force a drawing away from what is perceived to be an unwelcome threat.

The true test of the endurance of the U.S.-Japan scientific relationship is still to be made. Plans for expanding technical cooperation on a wholesome basis exist in Washington, but it remains to be seen whether they will be acceptable politically in the current environment of trade friction.

Intergovernmental Technical Cooperation: A Case Study The Treaty of the Meter and The International Organization for Legal Metrology

Edward L. Brady

Associate Director for International Affairs

David E. Edgerly

Acting Director, Office of Research and Technology Applications,
National Bureau of Standards

I. Introduction

The first article in this series pointed out that many different types of organization structure exist for international cooperation, each determined partly by previously existing organizations and partly by the objectives that the sponsors wish to accomplish. The second article related the case history of a major bilateral relationship—that between the United States and Japan. In this article we illustrate U.S. participation in intergovernmental organizations, using the Treaty of the Meter and the International Organization for Legal Metrology, two small but significant agencies, as examples.

II. Treaty of the Meter

The Treaty of the Meter, one of the oldest intergovernmental conventions still in effect, entered into force in 1875, with the United States as one of the original adherents. The need for an internationally accepted measurement system had become apparent during the preceding decades as trade expanded and buyers and sellers around the world found increasing problems in communicating quantitatively with each other. The French Government, which had invented the metric system, took the lead in organizing the International Commission on the Meter, which drafted a treaty intended to ensure

that the metric system would become a true *international* system, in which any nation that wished could have its say in helping to define the ways the world would measure any physical quantity. The system defined and refined by this community of scholars, now known as the *International System of Units*, or SI, has been extraordinarily successful; it has been adopted as the official system of measuring units by every nation in the world, with the exception of the United States and Brunei.

At the present time, 47 countries are adherents to the Treaty of the Meter; this includes all the more industrialized countries plus a few others that are not major factors in science, technology, or international trade.

The Treaty of the Meter establishes three components to carry out its mission. The International Bureau of Weights and Measures (BIPM), located in a park in Sevres, France, is the laboratory arm and also includes the secretariat that handles all documentation and manages meetings. The International Committee for Weights and Measures (CIPM), consisting of 18 metrologists each from a different country, sets policy and makes many of the operating decisions of the organization. Finally, the General Conference on Weights and Measures is the formal intergovernmental conference that sets the budget and ratifies the recommendations submitted by the CIPM.

For an organization the size of BIPM, only 59 persons, it covers a surprisingly broad range of technical subjects. The program includes research on measurement of mass, length, time, temperature, optical quantities, electrical quantities, ionizing radiation, gravity, and other physical quantities. Excellent contributions are made in these areas, which generally are dominated by the work of the major national metrology laboratories in the United States, Germany, UK, Soviet Union, Canada, and Australia.

The members of CIPM are usually the top officials of the national metrology

organizations of their home countries, but this is not always the case. The current U.S. member is Ernest Ambler, the Director of the National Bureau of Standards. However, the members serve in a personal capacity as a technical expert, not as an official representative of their government. To plan the detailed technical activities, the CIPM has established 8 Consultative Committees in areas such as electricity, ionizing radiation, etc., each chaired by a member of the CIPM. The National Bureau of Standards participates in all of these committees.

Each country pays a share of the budget, ranging from a minimum of approximately 0.5% to a maximum of approximately 10%. The United States, Germany, Japan, and the Soviet Union each pay the maximum amount, which by tradition guarantees each a seat on the CIPM, the policy-setting body. Other member nations share the remaining 14 seats.

The principal duties of the CGPM are to fix a budget for the following quadriennium and to approve the technical recommendations of the CIPM. For example, at the most recent General Conference, held in Paris in 1983, the major technical action was to approve a new definition of the meter, the unit of length on which the definitions of all American customary units are based. For those interested, the meter is now defined as the distance traveled by light in a vacuum in the fraction $1/299\,792\,458$ of a second.

During the past 112 years as the requirements of science and technology have rapidly become more demanding, the agencies of the Treaty of the Meter have steadily improved the version of the metric system of measurement with which they started. The current International System of Units is a triumph of ingenuity and perseverance.

III. International Organization of Legal Metrology

The International Organization of Legal Metrology (OIML) was established by

Convention in 1955. Its principal objective is to develop model regulations and methods of test which define acceptable levels of performance for measuring instruments, or for the conduct of specific measurements. There are currently 50 nations who are full members of OIML and another 27 nations that are corresponding members. Generally speaking, governments regulate the accuracy and suitability of measuring instruments used in the buying and selling of goods and services, in monitoring environmental pollution, in diagnosing and treating illness, and in monitoring workplace and general public safety. OIML activities are mainly aimed at getting governments to agree on uniform measurement requirements and to use such requirements, when appropriate, as the basis of national regulations. This facilitates free trade and helps to focus international attention on the importance of accurate and reliable measurement in support of technological development.

Organizationally, OIML consists of the International Bureau of Legal Metrology (BIML) and the International Committee of Legal Metrology (CIML). The BIML includes a small permanent staff headquartered in Paris, France, who are responsible for managing and coordinating the activities of the Organization. The CIML is a 50 member committee consisting of one representative appointed by each member government. It meets every 18 months and oversees the OIML technical working program consisting of some 200 committees and subcommittees developing model requirements in a wide variety of measurement areas. It is important to point out that BIML has no research laboratories and that all of the technical work of OIML is carried out by technical experts from various member nations who serve on the 200 committees and subcommittees developing technical recommendations.

The OIML budget, which is principally used to support the BIML activity, is derived from annual contributions from

member nations. The level of contribution is based upon a country's population. The United States, for example, contributes about nine percent of the total OIML budget. Every four years an International Conference of Legal Metrology is called to set policy for the Organization, adopt the output of the various technical committees, and establish a quadrennial budget.

Though OIML was established in 1955, the United States did not become a member until 1972. At that time, the Senate Foreign Relations Committee held hearings at which industry testified that the lack of U.S. participation had resulted in international requirements for measuring instruments that were creating obstacles to trade. As a result, the U.S. became a member and responsibility for day-to-day technical participation is assigned to the Department of Commerce, and through it the National Bureau of Standards. The State Department is responsible for overall participation and for the annual U.S. contribution to OIML.

United States presence in OIML is geared to strong technical level participation in the 200 technical committees and subcommittees. Of priority concern to the U.S. is the development of positions which satisfy our interest as regards:

- a. the identification of opportunities for U.S. measurement practices to be embodied in OIML International Recommendations;
- b. the prevention of impediments to U.S. trade that can result from restrictive technical or administrative requirements in International Recommendations;
- c. the development of International Recommendations which accommodate the reality of a decentralized system of legal metrology as found in the U.S.; and
- d. the development of sound management and administrative policies which will ensure that OIML operates as a viable international organization and that it effectively coordinates its aims

and objectives with those of other international organizations having similar objectives.

The U.S. currently is the secretariat for some 29 of the 200 technical committees and subcommittees within the OIML working program. For the most part, the decision to assume responsibility for directing the work of a committee is based upon interest in promoting U.S. measurement practice and in enhancing industry's ability to compete worldwide. For example, the U.S. recently completed work on an OIML Recommendation on electronic weighing instruments which sets approval requirements for government acceptance of all types of commercial scales. The U.S. scale industry had a very active involvement in the Recommendation. A similar effort is underway in the field of environmental pollution where a large U.S. national working group involving government and industry is developing draft OIML Recommendations for monitoring instrumentation. This work is important not only because it will assist U.S. industry, but also because of the pressing need worldwide to have accurate and reliable instrumentation for monitoring the environment.

The work undertaken by OIML has followed a fairly predictable course over the years. Initially, member governments were interested in coming to agreement on legal requirements for instruments used mainly in the commercial marketplace. For

example, weighing devices and fluid metering systems were among the first generic devices studied. Between 1955 and 1970, the bulk of the OIML Recommendations issued were in traditional weights and measures fields (mass, length, volume). Since 1970, the working program of OIML has expanded considerably, reflecting the interest of member governments to come to agreement on requirements for instruments in non-traditional legal metrology areas like health, safety, and environmental pollution. Since 1980, priority has been given to the development of requirements for electronic equipped measuring instruments and to a greater involvement in the development of test methods which government officials can use to determine that measuring instruments comply with established requirements.

United States participation in the OIML has to date proven to be very beneficial. The opportunity to meet and interact on a frequent basis with legal metrology officials from other national laboratories has been very useful in resolving common measurement problems. Secondly, the U.S. instrumentation industry has been given the opportunity to actively participate with NBS in developing positions on OIML matters and in serving on American delegations to OIML meetings. As a result, industry is better informed of requirements for trading with other nations and has taken advantage of these opportunities in marketing its products and know-how in OIML member countries.

Technical Assistance to Developing Countries

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To turn from the narrow microcosm of my own experience in working on assistance projects for rapidly developing nations to the macrocosm of United States policy is a hazardous leap. Yet, I must try that jump, as is implied by my acceptance of the invitation to contribute to this journal number. My viewpoints, by no means all novel, may have some merit even when applied more widely than within my accustomed horizons.

In absolute and relative terms, the United States has placed unprecedented effort and resources into assistance to other nations. A good part of this support flowed from private sources, much from religious, cultural, and sporting groups as well as from recent immigrants. Much more assistance has been channeled from the Federal Government through the Agency for International Development (AID) and predecessor agencies. This aid is approximately matched by support from international organizations, mostly affiliated to the United Nations (UN), and they also typically depend on a major share of funds from the United States. Recognized also should be the American private sector companies who, in pursuit of self interest, have taken remarkable risks in effective assistance to developing economies. Last, but certainly not the least in significance,

has been the American military establishment in helping the process of development. To all these endeavors Congress has been vocally supportive and clearly understanding of the issues despite budgetary restrictions and concerns of greater perceived interest to voters.

Appreciation abroad is typically restricted to a minority of officials who will recall a few development projects. Memories are short. There are exceptions, of course, especially where religious missions are active over long time periods. When Congress or companies impose conditions upon given aid, it is quite often resented by the recipient country's public opinion. I myself have had the privilege abroad to represent projects that were generally popular, but in off-duty moments, I often saw a need strongly to defend American foreign assistance policies and, more generally, the American ways which I, an immigrant myself, selectively enjoy (I here use American in the narrow sense, meaning the United States).

The American public generally is not much more enlightened about foreign assistance programs, and opinions are often critical. Indeed, it may well be true that the balance between security and economic aid needs some adjustment in a world in which military alliances may be

of decreasing interest to the superpowers, while trade agreements are likely to be of increasing benefit to the United States.

Remember the Marshall Plan! With billions of American dollars, war-torn Europe redeveloped its industrial might. The United States provided little more than the money and significant management skills. Western Europe was able to find enough remaining of its technical infrastructure and modernize much of its manufacturing industries by drawing on domestic know-how and expertise; as well as by purchasing latest American equipment.

After years of less uniformly spectacular results from aid to the less developed countries of Africa, Asia, and Latin America, there may still be people here who believe that historic successes can be achieved there with but money and management skills. The lesson we should have learned is that successes in disadvantaged countries come only if technical know-how is contributed from highly industrialized countries. Effective aid equally depends on cooperation with the scientific elite that typically exists in recipient nations. Underestimate of the locally available scientific expertise in its ability to turn to applied projects is a pitfall for planners and advisers from highly industrialized countries. Some experts from the West might be lured into this error by local conditions. In Thailand, the cause may be the widely accustomed personal modesty, in Pakistan it may be the aloofness of many scholars, in the Sudan the administrative lines could present an initial obstacle to cooperation with the indigenous scientific establishment.

Technical collaboration between donor and recipient nations is necessary for success; it certainly was effective in bringing about the "green revolution" and, to give two somewhat smaller-scale examples, it kindled a state-of-the-art instrument industry in Israel and opened the way for the Volkswagen manufacture in Brazil.

The case of Brazilian development gives an opportunity to discuss AID's general

policy to have projects initiated by local field offices in consultation with governments. In matters of science and technology, however, governments and indigenous industries frequently do not foresee clearly the specific needs and opportunities. In the absence of local technical advisory services such as in America are provided by the U.S. National Academies of Science and Engineering, and the National Research Council, AID has been wise to offer technical studies coordinated from Washington, with a view to giving advice in the field. For implementation projects, AID and the World Bank rarely press technical viewpoints beyond the local governments' inclinations. In Brazil, however, AID asked the National Bureau of Standards to support the laboratory of the State of Sao Paulo, the Instituto de Pesquisas Tecnologicas, because it was the best in staff and facilities. This action was very successful although the Brazilian government initially would have preferred AID support to be concentrated in federal laboratories. At this time, Brazil again is expressing some displeasure over American advice this time on environmental concerns arising from World Bank projects. Experts believe the advice is very sound and in Brazil's own interest.

In general, it seems to me that assistance projects in agriculture and life sciences have fared better than those for manufacturing industry. Good industrial projects typically depend on infrastructure for which it is difficult to obtain funding because its importance for development is not well understood, even in this country. Infrastructure projects do not directly result in a saleable product. Part of the economic benefits depends on avoidance of losses which are not clearly recognized in budgets. Furthermore, infrastructure projects are comparatively inexpensive. The assistance agencies are not well structured to deal with small projects, even those with potentially big leverage. When you present such ideas, you are apt to be advised to seek recognition as a sub-project of another existing

and related project. However, such established projects generally have existing set plans into which the new idea does not fit perfectly.

While on consulting assignments for AID, the World Bank, and other UN agencies, and even before my retirement while I was still representing NBS, I often felt a technical loneliness among the staff of assistance agencies. They seem strongly based in economics, finance, politics, and management, as indeed they must be. However, virtually all their programs and projects also hinge on technical judgments; they need, but generally do not have, in-house science and technology competence that can see and advise on the technical potential of the numerous opportunities existing in every country. Consultants cannot serve that purpose effectively. Even when their reports are openly endorsed, the technical focus and necessary pre-conditions are easily and unwittingly lost in the subsequent implementation.

Lest I be misunderstood, I should emphasize that consultants are also needed. Science and technology are highly specialized and ever-changing. Assistance agencies cannot possibly have experts current in every field. From the consultants' viewpoint, too, the relevant experience is often educative, stimulating, and humanly rewarding. In my own experience, I have found work with the assistance agencies pleasant and rewarding. Even my technical loneliness was often unexpectedly relieved by, for instance, a former professor of electrical engineering in a management role at the World Bank. A former technical staff member of the Armour Foundation (now the Illinois Institute of Technology Research Institute) was attached to AID in Vietnam at a time when the American endeavor was not yet completely lost. He, with support from NBS, established a Vietnam Standards Institute that gave effective services to fledgling industry. I am convinced that some industrial activity might have contributed to the population's conviction that

there existed a future worth a courageous self defense. AID's support for the Institute was too small and also too late. It played a negligible part in the last-ditch defense of Saigon. We have learned from the escaped director and a British consultant to the North Vietnam government that the Institute survives.

In the evaluation of past projects, there also seems to be a scarcity of technical inputs. Coupled with a commonly encountered lack of institutional memory which is a consequence of staffing policies, this situation makes it difficult to learn from mistakes and to enlarge successes. Colleagues of mine and I have written rather extensively, for example, on the output from the small share of non-convertible PL 480 funds from the sale of agricultural products to deprived countries. These had to be in excess of the needs of State Department and were allocated to NBS in competition with other U.S. agencies. Such funds were allowed to be used in Yugoslavia, Israel, India, Pakistan, Egypt, and Tunis. At NBS, we tried to evaluate the contributions these programs made both at NBS and abroad, but I have received not one comment from any American outside NBS on the value of the output of these projects. They probably had no influence on allocations of agricultural products to relief in subsequent years.

Evaluations are particularly apt in so-called AID graduate countries which have progressed in development to a level at which they do not need direct assistance from that source. These are, of course, likely strong future trading partners. Surely we should understand how their successes were achieved, and American policy might look at these countries for potential economic leadership among regional allies. Iran was such an AID graduate country when NBS Director Lewis Branscomb took a small team of Government scientists to explore the past and to propose policies to preserve future collaborations. Iranian officials at that time were still overwhelmingly friendly to the

United States. They cooperated warmly with the visiting team. However, they appeared, on more than one occasion, embarrassed by Branscomb's first question: "What do you recall of AID projects that had a positive impact?" After some hesitation, one response was: "American chicken production." The most satisfying response, however, was: "The American approach to solving problems."

In many recipient countries, for example Korea, memories of AID projects are more positive, but Americans should not expect too much in the way of historic knowledge and appreciation. Credit for successful development projects is preferentially awarded to the home team.

For planning new projects, donor institutions also tend not to accurately analyze the past, but they frequently follow some catch phrase that comes into vogue. Let me quote a few examples of major policy directions that for some time were applied:

- (1) "Import substitution creates home industries;"
- (2) "Stem the population explosion;"
- (3) "Small is beautiful;" and
- (4) "Help the poorest in the poorest countries."

All these are based on some good ideas, but they all also have severe limitations.

Some troubles that come with import substitution have been well recognized. Protection by import duties is soon followed by inferior quality of products that quickly become strongly disfavored by captive domestic consumers. These products then do not have a chance to compete abroad. Ecuador, for example, in the 70's found that this sequence of events was impossible to prevent by conscientiously enforced regulations for quality.

However, the policy of import substitution is not always wrong; and the opposite policy is not always right, which is to make just a very few products with selectively chosen available raw materials or in a specific field for which the nation has optimal resources. These products may

sell in international trade to economic advantage. Still one must guard against the problem of scale addressed by the catch phrase: "Small is beautiful." In fact, small rarely is economical. Thus small cannot afford to be "good."

NBS technical assistance has been specially hampered by the "poorest in the poor" directive. The nations that can best benefit by NBS assistance are those at the intermediate income level; that is, those whose economies are growing rapidly and whose technological infrastructures need strengthening in order to promote further development.

Above all, I would like to see all American assistance given based on the principal criterion of U.S. self-interest. Congress and the American public see such self-interest quite clearly in military assistance, but economic and commercial benefit to the United States in other aid projects is not so clear. I believe that discussion of U.S. self-interest would not at all alienate our partners in the rapidly developing world.

Let us next look at assistance from the angle of newly industrializing nations. They see the United States as an industrial, military, political, commercial, and cultural giant. Moral leadership may also be attributed to individual Americans. The huge success of the country is linked to material wealth and that in turn is regarded as the product of science and technology at their highest contemporary level. These nations want a doorway into these lofty realms and are frustrated that science and technology does not occupy a high place in American diplomacy.

The typical representative from newly emerging countries does not expect to see a completely new home-based technology invented there and applied there in practice; but he feels sure that the inventiveness of the technical elite in his country could be encouraged to be as effective as rivals from other countries in developing individual products that could fit into bigger systems as well as by inventing patentable refinements of existing systems.

It is here that in discussions the U.S. self-interest should be introduced. Assistance in the form of technology transfer could then be offered where mutual interest is recognized. One of three basic modes for technology transfer could be employed:

Mode 1. Carefully selected and qualified representatives of the assisted nation would read, study, and otherwise acquire openly available, generally published, scientific knowledge. They would bring that information home to apply in their own innovative projects aiming at domestic and international markets with novel products and services, as well as for establishing new centers of excellence in their own countries.

American universities and some U.S. research centers have proved superb sources for that kind of long-term training. Historic evaluation of the effect of Americans' studies in Europe during the late 19th and early 20th centuries could have pointed the way for assistance agencies to choose that kind of assistance almost before any other. That choice would have been reinforced by an analysis of Japanese and Korean experience in later years. Hundreds of thousands of foreign students are now supported by many American organizations and universities. However, many assistance agencies of the UN and AID prefer to fund studies of only a few weeks or months. Such assignments may well be effective in administrative and even economic studies if carefully anticipated by guided reading and language studies before arriving in the United States. However, for engineers and scientists minimum periods of two to three years are required for effective education.

Mode 2. Assistance would be through licensing and joint ventures, generally involving partial or progressively more complete manufacture in the developing country, maintenance services,

etc., all under cooperative agreements in which know-how is shared and confidentialities are honored. The assisted country not only benefits directly but the people involved gain skills and abilities. In the course of time, self-reliant initiatives may then lead to related products, processes, and services for which the assisted country organization could itself become a successful licensor.

In America and indeed in most Western countries, governments do not own the great majority of the rights to industrial know-how. American and multi-national companies have long known how to use this mode to their own, at least temporary, advantage. AID has explained to governments of rapidly developing countries how useful it can be to provide the atmosphere and regulations that make it attractive to high-technology companies to establish such cooperations. UN agencies have tended to cloud the issue by calling for philosophical and philanthropic goals, particularly emphasizing the viewpoints and demands of the less developed countries.

Mode 3. Here I really reveal my personal strong bias. In this mode, assistance would be given in standards and measurement science. For standards not only include the documents which manufacturers use for their products and processes, but also the specifications on which rest commerce and trade. They are the link to legal justice, public safety, and environmental concerns. If we in America hope for developing countries to be our predominant trading partners of the future, let us prepare to help them so that they can participate with us to develop a mutually agreeable relationship by reliably testing for compliance to standards. The word standards also refers to the objects by which measurements are made. Based on such standards is the universal science called metrology, which

serves virtually all other sciences and technology. Accurate measure is the key to satisfactory retail markets, as well as to the design and construction of the most awesome nuclear power station and to the elucidation of protein structure and function.

The world rightfully praises Japan for accepting and fully implementing a consultant's thesis on quality control. Metrology is the obvious extension of that thesis into high technology. Time was when quality would be appraised by look, or sound, or feel. Increasingly, quality of products can only be measured by accurate quantitative assessment of specific properties. And that is metrology. More and more industrializing countries recognize the need for a national measurement system. Korea, in the past ten years, has demonstrated the effectiveness of this strategy. China, under both of that country's regimes, is now following that course with impressive vigor.

Modern life, manufacture, and product testing depend on measurements by sophisticated instruments. The manufacturer of instruments must not only show the user how to maintain calibration by metrology, but how these instruments give reliable results by metrology. As long as American instrument industry remains competitive for use by emerging countries, it is in American interests that rel-

evant metrological comprehension is found in the customer nation.

Standards and metrology have further attractions as topics for assistance projects. Metrology by definition is mostly non-proprietary. Competitiveness in metrology consists in showing exactly why and how good you are for all to see. Metrology to be useful must be credible; to be credible, it must be open. In the United States, NBS has followed that policy with success and distinction. This policy has also enabled the NBS staff to contribute effectively in many development assistance projects. Many current and former NBS staff members feel conversely that these projects have added meaningful reward to their career.

It is easy for me to sum up my hopes for U.S. policy for assistance to rapidly developing nations: more academic level education to a technical elite group; more industrial agreements with strong mutuality of benefits; and standards and metrology raised to a topic for special attention. After all programs have been implemented, I favor careful technical evaluation with a special feature of listening to the impressions of the partners that should have been assisted. American assistance for development in other countries has in our age created and should continue to erect some of the finest historic monuments both concrete and abstract.

International Cooperation in Science and Technology: The Role and Functions of Embassy Science Attaches

Abraham S. Friedman

The first American scientist to represent his country abroad was, in addition to being an outstanding man of science, also a diplomat, negotiator, commercial representative, cultural emissary and man-about-town. Benjamin Franklin, the newly independent American States' first Minister to France (December 1776-1785), was respected by the French as a scientist and his scientific papers and correspondence, which had been translated and published in France in 1773, were as widely read in France as in this country at the time. He was a member of the Royal Academy of Sciences of Paris, the Royal Societies of London and Gottingen, and the Philosophical Societies of Edinburgh, Rotterdam and Philadelphia. As noted in a June 1976 Congressional Research Service Report on Science, Technology, and American Diplomacy in the Age of Interdependence, "Under the influence of men like Franklin and Jefferson, science and technology were closely interrelated with American diplomacy in the early years of the Republic, [but subsequently] interaction of diplomats . . . with science and technology appears to have diminished."

The significance of science and technology in international relations became apparent during World War II. Scientific Missions were established in the embassies of the Allies in order to enhance cooperation in joint technological research and development. Thus, the U.K. Scientific Mission in Washington carried out liaison with the United States on the atomic bomb program and the U.S. Science Mission in London cooperated with U.K. scientists working on radar.

Today's Science Attaches have more varied responsibilities. The Science Attaches of many countries, especially those serving in the United States and other industrialized countries, are primarily engaged in gathering science and technology information and reporting on developments in science and technology of the host country. Important as that function is, it is not, however, the major mission of our Science Attaches (although there is currently much pressure being put on the State Department to make it so).

The Science Attache or Counselor of an Embassy for Scientific and Technological Affairs is primarily responsible for identifying and interpreting the impact of

scientific and technological developments on policy matters of concern to the Embassy and the Department of State and recommending appropriate actions. He generally reports to the Ambassador through the Deputy Chief of Mission (DCM) and is required specifically to:

- (a) Advise the Ambassador, DCM and Embassy officers on a broad range of scientific, technological, environmental and ocean matters which are of potential significant importance to U.S. foreign policy objectives.
- (b) Provide policy analyses and recommendations to the Embassy, the State Department and U.S. technical agencies, including means to enhance U.S. access to host country science and technology, and to stimulate bilateral and/or multilateral cooperative programs of mutual interest.
- (c) Based on a current comprehensive understanding of State Department and U.S. technical agency program requirements and objectives, represent and interpret U.S. government policies and programs to appropriate host country officials.
- (d) Provide timely analyses and reports on scientific, technical and environmental policies, programs and objectives of the host country which have the potential to affect U.S. interests.
- (e) Support and advise the Department of State and U.S. technical agencies on bilateral and other programs and activities with the host country, participate in the negotiation of agreements of interest to U.S. technical agencies, and represent them at technical meetings.

Different countries define the mission and duties of their science representatives in accordance with their differing national interests and priorities. The Canadians, in a foreign policy report of 1970, stated that "the impact of science and technology on international affairs is becoming increasingly significant and varied as new advances are made [and that it therefore] will be important for Canada to be as-

sured access to scientific developments abroad and to participate in international cooperation in scientific undertakings." Their primary interest is access to technological information.

A French report on science policy (published in *Science et Vie*, February 1979) noted that "the objective is to establish scientific cooperation on three levels: in the United States, as always, to stimulate French research and researchers; in all of Western Europe from Norway to Gibraltar and from Iceland to Austria, to attain in Europe that critical scientific mass necessary to balance American power; finally, the rest of the world should be handled on a case by case basis." The French report further notes that France has the greatest number of Science Counselors and Attaches in the world: in 40 countries! The United States has Science Counselors or Attaches in our Embassies in 22 countries plus an additional 3 accredited to International organizations (IAEA, EC, and OECD). Furthermore, while most of our science offices abroad are staffed by a single person (in our Paris Embassy we have an Assistant Science Attache in addition to the Science Counselor) the French have, in their Washington Embassy, a Science Counselor plus six Science Attaches—each an expert in a particular scientific or engineering discipline (geology, space science, nuclear physics, biotechnology, etc.) They also have Science Attaches serving in a number of their Consulates, particularly those in the high-tech areas of the United States, such as in Boston, New York, Chicago, Houston and San Francisco. In addition, about twenty young scientists (*cooperants*) are working for the French Science Missions in lieu of military service. It is thus apparent that the rationale and objectives of the French Science Attache program are very different from ours. The aforementioned French report noted that the Science Attaches' reports make it "possible to compare results obtained abroad with those obtained in France in the same areas, to orient French laboratories toward promising sectors of re-

search or towards sectors which lag behind."

The development of the atomic bomb made it more apparent than ever that scientific and technological progress had important international policy implications and that the Department of State had a significant role to play. In the fall of 1949, Lloyd Berkner was appointed as a Special Consultant to the Secretary of State to advise him on the formulation and implementation of the State Department role in international science policy. Berkner headed a State Department Steering Committee on International Science Policy and the Berkner Committee Report, issued in 1950, was the first comprehensive assessment of the significance of science and technology in U.S. foreign policy and diplomacy. An office of Science Advisor was created in the State Department and several Science Attaches were assigned overseas. However, Science had a very low priority in the State Department of the early '50's and by 1956, the Office of Science Advisor consisted of a Foreign Service Officer and two secretaries. It took Sputnik (October 1957) to remind the Administration of the important international implications of science and technology. The position of Science Advisor to the Department of State was reestablished and Wallace Brode, Associate Director of the National Bureau of Standards and President of the American Association for the Advancement of Science, was named to the post. The functions of the Science Attaches were, however, not very clearly defined and many of them were retired professors who served more as cultural attaches for the sciences than as scientist-diplomats.

A number of studies and reports subsequent to the Berkner Report followed in an effort to better understand and define the State Departments role in science, technology and diplomacy. Among the more important of these studies were the report of the Science and Foreign Affairs Panel of the President's Science Advisory Committee (1962), several reports by Frank Huddle on Science, Technology,

and American Diplomacy for the House Subcommittee on International Security and Scientific Affairs (1970, 1976), and T. Keith Glennan's Report to Deputy Secretary of State Charles Robinson on Technology and Foreign Affairs (December 1976).

The 1979 Foreign Relations Authorization Act, P.L. 95-426, required that the President, pursuant to Title V of the Act, submit to the Congress an annual Message and Report on Science, Technology and American Diplomacy. The substantive report on the international activities of the U.S. Government is prepared by the Department of State in cooperation with other relevant agencies. Under Title V of the Act, the State Department has been assigned primary responsibility for the coordination and oversight of all major science and technology agreements and activities between the United States and other countries and international organizations; the Department of State manages the international science and technology activities of the U.S. Government as a fundamental aspect of foreign relations. Within the Department of State, the Bureau of Oceans and International Environmental and Scientific Affairs (OES) is the responsible office and it is that bureau which backstops the Science Attaches abroad.

In the 1950's and early '60's there was little effective backstopping support for the Science Attache program. It wasn't until the creation of the Office of International Scientific and Technological Affairs (SCI) in 1965 under the directorship of Herman Pollack, replacing the Office of the Science Advisor, that an efficient program for backstopping the Science Attaches came into effect. Even then, the staff of SCI was quite small (32, including secretaries, in 1967) to handle the 22 Science Attaches and deputies assigned abroad. By 1975 the staff of SCI had grown to 98. That year, the SCI Office became, by Act of Congress, the Bureau of Oceans and International Environmental and Scientific Affairs and the first Assistant Secretary of State appointed to head the OES

Bureau was Dixy Lee Ray. Today, OES has 142 full time employees, several part time employees and a few people detailed from other agencies. As a result of recent budget cuts, however, the staffing of OES is being drastically reduced in FY 1988. As of the beginning of this year there were 25 Science Counselors or Attaches, a few assistant Science Attaches, and 5 Attaches representing other U.S. Government Agencies (e.g.—DOE, NASA, NOAA). Some of the Science Attaches are accredited to several countries in a region. An important innovation introduced several years ago was the requirement that every embassy without a Science Attache assign an officer to report on science activity in the host country. These science reporting officers are generally junior officers whose principal duties are in other areas of the Mission and who generally have no science background.

The recruitment and qualifications of our Science Attaches has been the subject of much discussion since the inception of the Science Attache program. Should the Science Attaches be experienced scientists or engineers with some exposure to or understanding of diplomacy? Or should the Attache be a foreign service diplomat with some scientific training?

In the past, most of the Science Attaches were scientists or engineers and

came from outside the State Department—most frequently from other U.S. government agencies such as the AEC, NBS, etc. The AEC was, in fact, the major supplier of State Department Science Attaches. This was primarily because (a) the Atomic Energy Commission had a large number of scientists with experience in international cooperation and an understanding and appreciation of the foreign policy implications of atomic energy, and (b) the AEC, more than most USG technical agencies, had a long and continuing history of cooperation with the State Department in the negotiation of bilateral agreements for nuclear cooperation and in supporting such international agencies as the IAEA, Euratom, the OECD's Nuclear Energy Agency and the Interamerican Nuclear Energy Commission of the OAS. Thus, at one time or another, scientists from the AEC served as Science Attaches or Counselors in Bonn, Brussels, London, Madrid, Ottawa, Paris, Stockholm, Vienna, Brasilia, Buenos Aires, Mexico, Seoul, and Tokyo.

Today more and more of the Science Attaches are State Department foreign service officers and many of them have only had little or no science training. Whether it is easier in a reasonable period of time to teach a scientist the art of diplomacy or to teach science to a diplomat is a question I leave to others.

Listed below are the Science Counselors and Attaches as of the beginning of the 1988 fiscal year:

POST	INCUMBENT	TITLE
<i>Europe</i>		
Ankara	John MacGaffin	Counselor
Belgrade	Thomas Vrebalovich	Attache
Bonn	Edward Malloy	Counselor
Brussels (EC)	Patricia Haigh	S & T Officer
Budapest	Thos. Schlenker	Attache
London	James Devine	Counselor
Madrid	Ishmael Lara	Attache
Moscow	John Ward	Counselor
Paris	Allen Sessoms	Counselor
Paris (OECD)	Robert Carr	Counselor
Rome	Gerald Whitman	Counselor
Vienna (IAEA)	Carlton Stoiber	Counselor
Warsaw	Gary Waxmonsky	Attache

Science Counselors and Attaches continued

North and South America

Ottawa	Francis Kinnelly	Counselor
Mexico City	Roy Simpkins	Counselor
Brasilia	James Chamberlin	Counselor
Buenos Aires	Robert Morris	Attache

Middle East and Africa

New Delhi	Ahmed Meer	Counselor
Tel Aviv	Anthony Rock	Attache
Cairo	Francis Cunningham	Counselor

Asia and Pacific

Beijing	Pierre Perrolle	Counselor
Seoul	Jerome Bosken	Attache
Tokyo	Richard Getzinger	Counselor
Jakarta	Jeff Lutz	Attache

BIODATA

Justin L. Bloom is president of Technology International, Inc., of Potomac, Maryland, a small consulting organization specializing in foreign scientific and technical information and international technology transfer. Mr. Bloom's career has spanned 39 years, following his graduation from the California Institute of Technology. He has worked as an engineer and manager in the development of petrochemicals, nuclear materials, and radioisotope applications. During 24 years of service with the U.S. Government, he was technical assistant to individual Commissioners and to the Chairman of the U.S. Atomic Energy Commission. In subsequent service with the Department of State, he was Counselor for Scientific and Technological Affairs at the American Embassies in Tokyo and London. He retired from the Foreign Service in 1983 with the rank of Minister-counselor.

Mr. David Edgerly is currently the United States representative to the International Organization of Legal Metrology (OIML), and a Vice President of the International Committee of Legal Metrology. He has extensive experience in the fields of legal metrology and standardization and has worked closely with American industry in structuring U.S. technical level participation in over 100 OIML

technical committees and working groups developing international requirements for scientific and measuring instrumentation.

Dr. Abraham Friedman is a retired Senior Foreign Service Officer who has served as Counselor for Scientific and Technological Affairs in Mexico City, Bonn and Paris. He also worked at the National Bureau of Standards and for the U.S. Atomic Energy Commission where he served in the American Embassy in Paris as the AEC European Scientific Representative and later was AEC Director of International Affairs.

H. Steffen Peiser, born in Germany in 1917, entered Cambridge University in 1936 and had a varied career about equally divided between:

1. *Academic research*—Cambridge and London Universities, England
X-ray crystallography.
2. *Industrial research*—Imperial Chemical Industries and Hadfields Steel
Chemical and metallurgical crystallography.
3. *Public sector research*—U.S. National Bureau of Standards
Crystal chemistry and metrology.
4. *U.S. National Bureau of Standards*—
International relations.

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Anthropological Society of Washington	Edward J. Lehman
Biological Society of Washington.....	Austin B. Williams
Chemical Society of Washington	Jo-Anne A. Jackson
Entomological Society of Washington.....	Manya B. Stoetzel
National Geographic Society	Gilbert Grosvenor
Geological Society of Washington	James V. O'Connor
Medical Society of the District of Columbia	Charles E. Townsend
Columbia Historical Society	Paul H. Oehser
Botanical Society of Washington	Conrad B. Link
Society of American Foresters, Washington Section	Mark Rey
Washington Society of Engineers.....	George Abraham
Institute of Electrical and Electronics Engineers, Washington Section.....	George Abraham
American Society of Mechanical Engineers, Washington Section	Michael Chi
Helminthological Society of Washington	Robert S. Isenstein
American Society for Microbiology, Washington Branch	Vacant
Society of American Military Engineers, Washington Post.....	Charles A. Burroughs
American Society of Civil Engineers, National Capital Section.....	Carl Gaum
Society for Experimental Biology and Medicine, DC Section	Cyrus R. Creveling
American Society for Metals, Washington Chapter	James R. Ward
American Association of Dental Research, Washington Section.....	Eloise Ullman
American Institute of Aeronautics and Astronautics, National Capital Section	Paul Keller
American Meteorological Society, DC Chapter	A. James Wagner
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American Society of Plant Physiologists, Washington Area Section.....	Walter Shropshire, Jr.
Washington Operations Research/Management Science Council	Doug Samuelson
Instrument Society of America, Washington Section.....	Carl Zeller
American Institute of Mining, Metallurgical and Petroleum Engineers, Washington Section.....	Ronald Munson
National Capital Astronomers	Robert H. McCracken
Mathematics Association of America, MD-DC-VA Section.....	Alfred B. Willcox
D.C. Institute of Chemists	Miloslav Rechcigl, Jr.
D.C. Psychological Association	Bert T. King
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American Fisheries Society, Potomac Chapter	Robert J. Sousa
Association for Science, Technology and Innovation.....	Ralph I. Cole
Eastern Sociological Society	Ronald W. Manderscheid
Institute of Electrical and Electronics Engineers, Northern Virginia Section	Ralph I. Cole
Association for Computing Machinery, Washington Chapter.....	James J. Pottmyer
Washington Statistical Society	R. Clifton Bailey

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